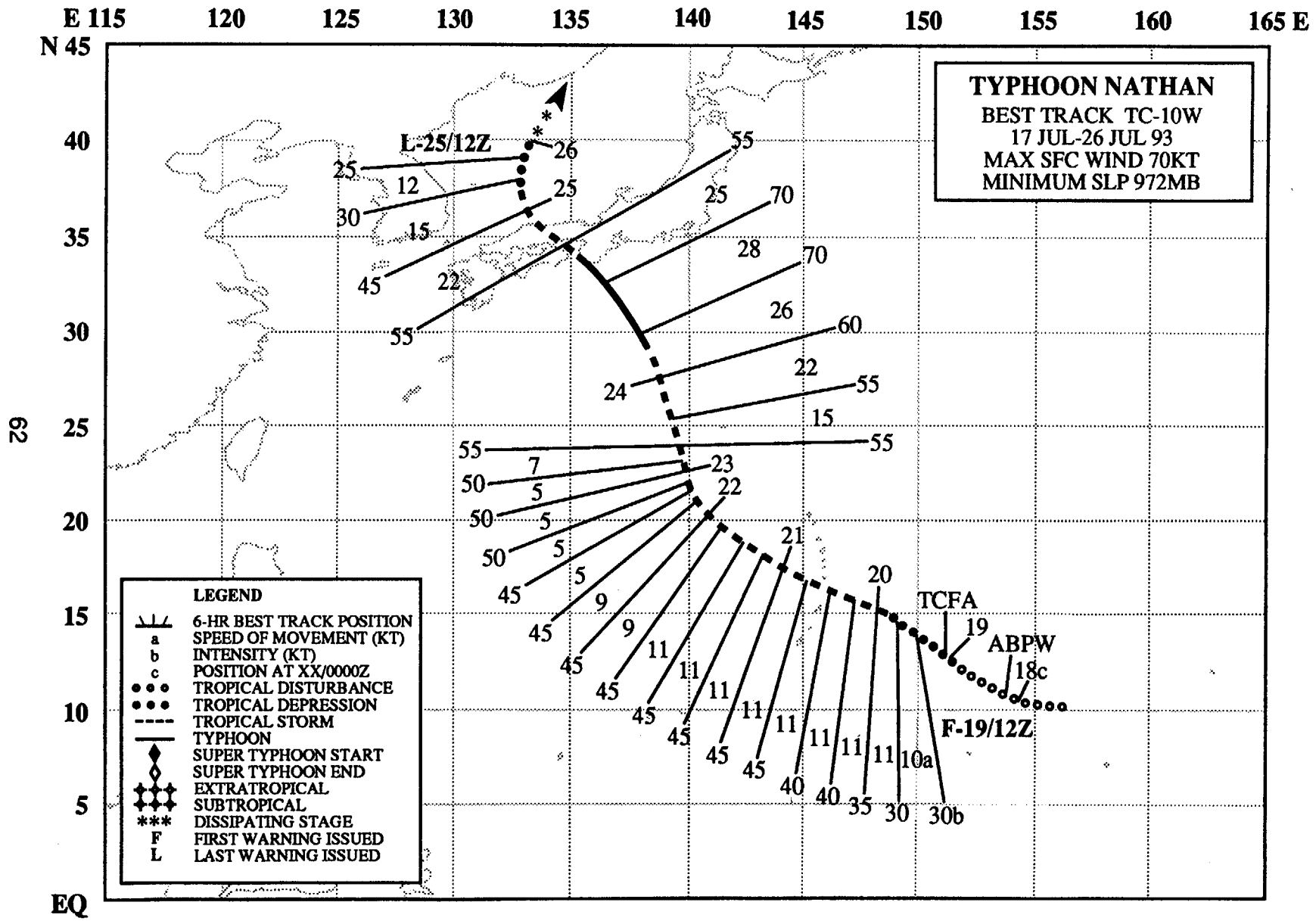
E 115
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EQ
TYPHOON NATHAN
BEST TRACK TC-10W
17 JUL-26 JUL 93
MAX SFC WIND 70KT
MINIMUM SLP 972MB
L-25/12Z
TCFA
ABPW
F-19/12Z
LEGEND
6-HR BEST TRACK POSITION
a SPEED OF MOVEMENT (KT)
b INTENSITY (KT)
c POSITION AT XX/0000Z
TROPICAL DISTURBANCE
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON
SUPER TYPHOON START
SUPER TYPHOON END
EXTRATROPICAL
SUBTROPICAL
*** DISSIPATING STAGE
F FIRST WARNING ISSUED
L LAST WARNING ISSUED

TYPHOON NATHAN (10W)

I. HIGHLIGHTS

After passing through the central Mariana Islands, Nathan interacted with a monsoon gyre which had formed in the Philippine Sea. Approaching the SW-NE oriented cloud band associated with the monsoon gyre, Nathan turned to the north to occupy a position at the northeastern end of that cloud band. From this position, Nathan accelerated rapidly (northward at first, then tending more northwesterly); and, breaking free of the monsoon cloud band, raced across southwestern Japan. Later, it entered the Sea of Japan, where it slowed in forward speed and dissipated. Operationally, Nathan was most notable for it's impact on Exercise Tandem Thrust in the Mariana Islands and it's rapid acceleration towards Japan. JTWC forecasts were hampered by the inability of the NOGAPS model to simultaneously handle a cutoff low south of Kyushu as Nathan rapidly approached Japan.

II. CHRONOLOGY OF EVENTS

July

170600Z - An area of persistent convection within the monsoon trough, northwest of Pohnpei, resulted in the first mention of the disturbance in the Significant Tropical Weather Advisory.

190200Z - An increase in both the amount and curvature of the convection east of the Mariana Islands, led to issuance of a Tropical Cyclone Formation Alert.

191200Z - Consolidation of central cloudiness and the resulting satellite intensity estimate of 25 kt (13 m/sec) prompted the first warning. Post analysis of satellite and synoptic data indicated that the formation of the tropical depression most probably occurred 12 hours earlier at 190000Z.

200000Z - Based upon a satellite intensity estimate of 35 kt (18 m/sec), Nathan was upgraded to a tropical storm.

240600Z - The appearance of a ragged, cloud-filled eye and a satellite intensity estimate of 77 kt (40 m/sec) led to Nathan's upgrade to a typhoon.

251200Z - The final warning was issued on Nathan as it dissipated in the Sea of Japan.

III. IMPACT

The approach of Tropical Storm Nathan towards Saipan and Tinian in the central Mariana Islands hindered operations during Exercise Tandem Thrust.

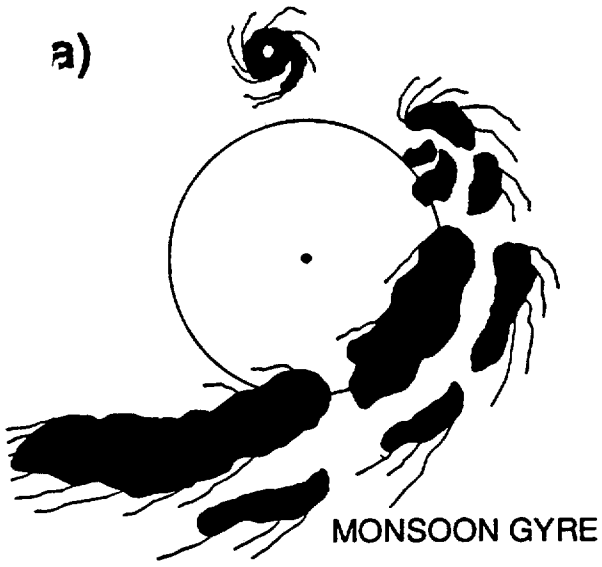
IV. DISCUSSION

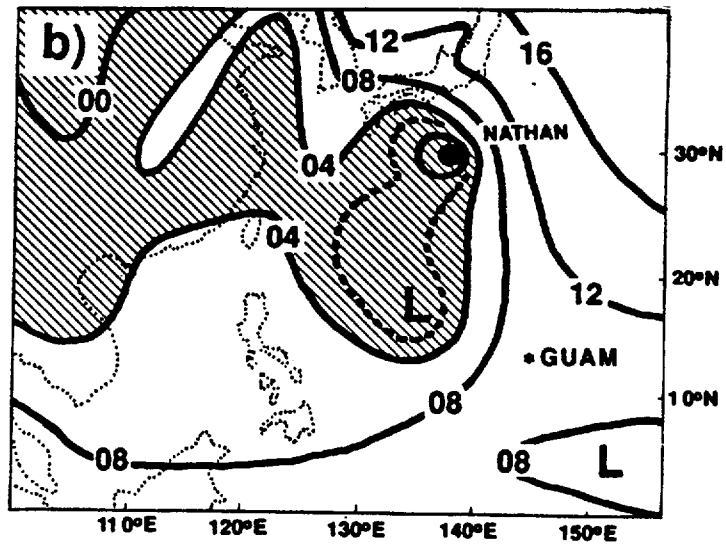
During the latter half of July 1993, the monsoon circulation of the western North Pacific became organized as a monsoon gyre (see definition in Appendix A and Figure 3-10-1). The monsoon gyre of July 1993 was associated with the formation of two and the motion of three very small tropical cyclones: Nathan, Ofelia (11W), and Percy (12W). Fortuitously, the Office of Naval Research and the Naval Postgraduate School were conducting a mini-field experiment, Tropical Cyclone Motion 1993 (TCM-93) (see Harr et al., 1993 for details), during the lifetime of this monsoon gyre. In support of TCM-93, an Air Force Reserve WC-130 weather reconnaissance aircraft from the 815th Weather Squadron was deployed to Guam to obtain measurements in and around tropical cyclones in the western North Pacific.

By 21 July, an independent large-scale cyclonic vortex had formed in the tropics of the western North Pacific. This vortex and its accompanying low-pressure area moved westward over the next 10

days, and influenced the motion of Nathan, Ofelia (11W), and Percy (12W). In each case, the tropical cyclone emerged from the downstream head of the monsoon cloud band, escaped from the gyre circulation and followed a "north-oriented" track (JMA, 1976) over Japan. Noted by Harr et al. (1993), each storm formed westward of the previous storm as the monsoon gyre drifted westward (Figure 3-10-2). By the first of August 1993, the monsoon gyre had merged with the low-pressure area over the Asian land mass.

During the westward migration of the July 1993 monsoon gyre, a successful forecast of sequential tropical cyclone development (each predicted to form to the west of the one prior) in the northeastern quadrant of the monsoon gyre was made by the TCM-93 forecast team in conjunction with JTWC forecasters. Three aircraft missions were flown during the period of genesis and intensification of the second gyre-related tropical cyclone, Ofelia (see Harr et al., 1993). The TCM-93 data set may provide a means to examine the mechanisms leading to the formation of midget or very small tropical cyclones in the peripheral cloud band of a monsoon gyre.





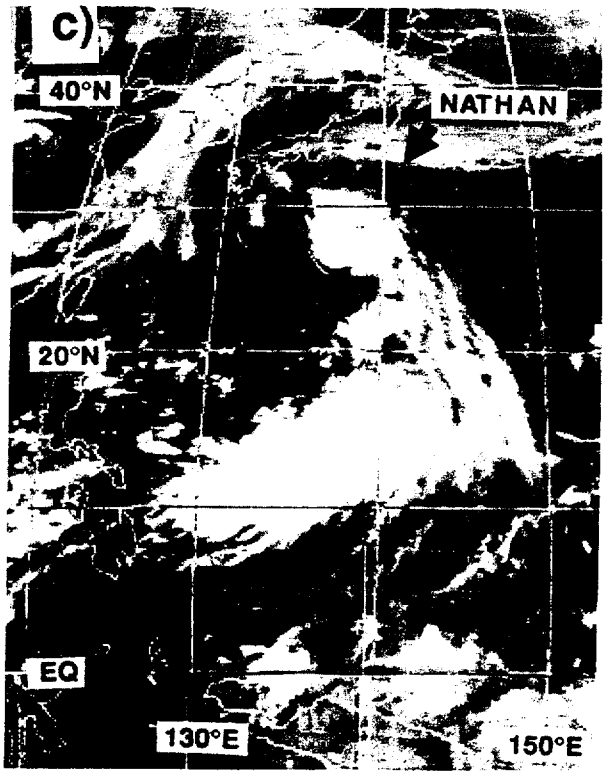


Figure 3-10-1 Depiction of a monsoon gyre. a) Schematic illustration of a monsoon gyre's cloudiness and pressure. Solid black cloud silhouettes represent areas of deep convective, single filaments indicate cirrus orientation and the circle depicts the region of large-scale lowest surface pressure surrounding the center (dot) of the monsoon gyre. b) Surface pressure analysis for 240600Z July of Nathan embedded in a monsoon gyre. Pressure contours are every 4 mb with areas of 1004 mb or less hatched. c) 240000Z July infrared GMS image of Nathan and cloudiness associated with a monsoon gyre.

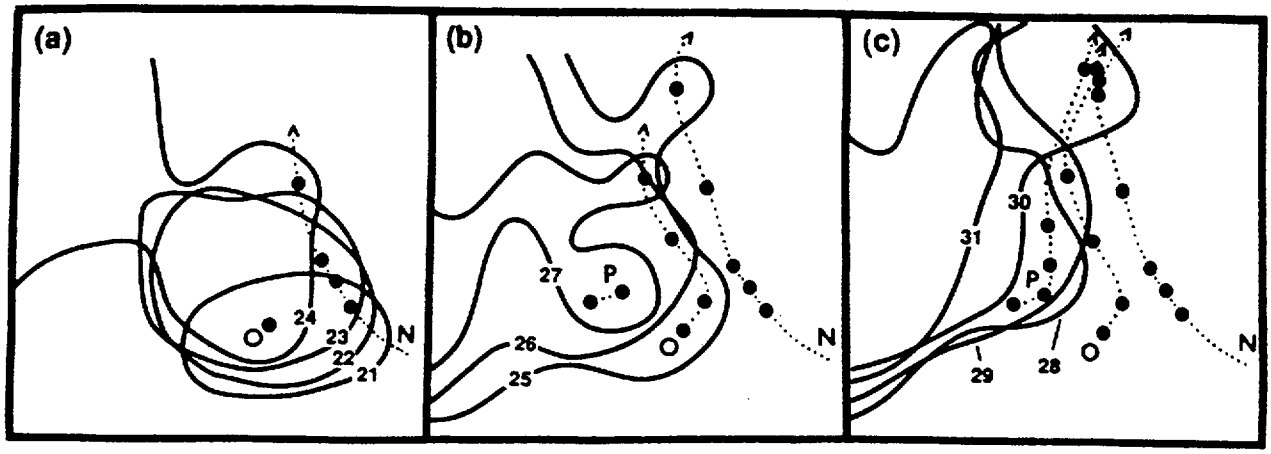


Figure 3-10-2 Illustration of the west-northwestward movement of the monsoon gyre of July 1993. a) The 1008, 1008, 1006 and 1004 mb contour of sea-level pressure (SLP) at 06Z July 21, 22, 23 and 24 respectively. b) The 1006 mb contour of SLP at 06Z July 25, 26 and 27. c) The 1006 mb contour of SLP at 067Z July 28, 29, 30 and 31. Dots show 06Z position of Nathan (N), Ofelia (O) and Percy (P) which show on each panel.